

The slide features a yellow banner across the top. A green swoosh starts from the left edge, curves over the banner, and ends on the right. A black circle with white dots is positioned on the left side of the banner, with a green line extending from it towards the left edge of the slide.

# NPS GIGA Lab Testbed for CKM Projects

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# What is the GIGA CODE Lab?

- ✱ Name: **Global Information Grid, Agents, and COllaborative Decision Environments**
- ✱ Mission: *Experimental studies of Global Information Grid Operation and Applications*
- ✱ Products:
  - *Testbed facilities for GIG NOCs, collaborative decision environments, agent grid, and network-centric human-agent habitats,*
  - *Experiments,*
  - *Thesis Projects,*
  - *Class Projects,*
  - *Research proposals, papers, conference presentations.*



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# Research Focus on Sensor-Decision Maker Networking and Collaborative Technologies

Hez Barge Mark Davis John Shwent	Wireless Collaborative Network for Relief Operations Coordination and Control	<b>Dynamic Multipath Networks, Adaptable to C2/Adaptive Management</b>  <b>Distributed Collaborative C2/Shared SA</b>  IST, HLS, integration with PACOM Virtual Civil-Military Coordination Center.
Leroy Dennis Michael Ford	Ubiquitous Surveillance Network Testbed	<b>Dynamic Multipath Networks Adaptable to C2</b> IST, HLS, NPS Code 05.
Steve Brzostowski Larry Smith	Collaborative Technology and Situational Awareness Systems for Airborne Mission Planning	<b>Distributed Collaborative C2/P2P C2</b>  IST, C4I, CIRPAS



# Situational Awareness and Collaborative Networking

Sam Chance Marty Hagenston Clyde Richards	Using a Semantic Web Application Employing Mobile Software Agents To Improve Military Operations	<b>Distributed Collaborative C2/Agent Grid</b>  IST, CS, SE-Wayne Meyer Institute of Systems Engineering
Jack Fay	Transforming Fleet Network Operations with Decision Support and Augmented Reality Technologies	<b>Distributed Collaborative C2/ NOCs Collaboration/Adaptive Network Management</b>  IS, CS, Center for Wireless Mobile Devices at Cebrowski Institute, <b>NPS Fleet Transit Experiment</b>
James Nasman	Fusion of Augmented Reality and Collaborative Technologies to Support Fleet Aviation Maintenance	<b>Distributed Collaborative C2/Shared SA</b>  IS, CS, Center for Wireless Mobile Devices at Cebrowski Institute, <b>NPS Fleet Transit Experiment</b>
Chris Manuel	UAV Networking for Special Operations Reconnaissance Missions	<b>Dynamic Multipath Networks Adaptable to C2/Adaptive Network Management</b>  IST, Special Operations, EE <b>NPS UAV Networking Experiment</b>



# GIGA Lab Testbed Infrastructure

- ✱ **Network-Physical layer segments:** wireless LAN, NASA ACTS Ground Station, Internet 2 Node (Server Iron, IronView), GPS enabled PDAs/handhelds, federated student satellite network ground station, UAV links, deck operation sensors, surveillance sensors
- ✱ **Application layer, collaborative C2 and situational awareness environment:** mobile Peer-to-Peer and Client-Server collaborative testbed (Groove system and NPS agent facilitators), agent grid (DARPA CoABS platform), GPS based situational awareness and monitoring agents.
- ✱ **Adaptive Network Management Environment:**
  - Management Nodes (NOC segments): Spectrum, and Solar Wind systems, End-to-End VoIP system, terrestrial NOC for the Nemesis Project, ACTS Ground Station. Management Nodes (NOC segments): Spectrum, and Solar Wind systems
  - Multiagent CoABS middleware (DARPA) integrated with SNMP MIB agents
- ✱ **Network Simulation Modeling** segments: OPNET-STK based models of UAV LANs, UAV-LEO satellite networking, sFlow and SNMP MIB management agents.
- ✱ **Integrated Management Environment :** network-centric human-agent habitats





## Background Studies: Peer-to-Peer Self-Aware Collaborative C2 Environments



# Adaptive Wireless Networking for Support of P2P Collaborative C2







# Shared Situational Awareness for Small Expeditionary Units



# P2P Collaboration via Groove: Maintaining Location Awareness Feedback to Small Unit Members

**P2P LOE 13Mar02 - Links - Groove**

File Edit View Options Help

Go To P2P LOE 13Mar02 Web Browser TM5 (Manager)

Back Forward Stop Reload Add Favorite Up Browse Together

<http://localhost/loe/loemaps.asp>

Invite

**Active**

TM5

**Online**

Bordetsky, Alex

**Not Online**

- Adam Michels (...)
- Crowson, Jeff
- Heather Penta
- Kemple, Bill
- Kline, Jeff
- Pilnick, Steve
- Rulof, Rob F.
- Sawyer, Lee
- TeamSpare
- Thate, Tim
- TM1
- TM2
- TM3
- TM4

**Conversation**

Hold-to-Talk

Hide Chat (1)

☐ Navigate Together

**Peer-to-Peer Limited Objective Experiment**

**Identity: Local\_CP** [Back](#)

Target type: ☒ Terrorist ☐ Bomb type to be defined

Your last known Longitude: -121.530760°, Latitude: 36.357560° **GPS is down**

Done

Brainstorming Documents Task List Schedule **Links (1)** Contacts Add Tool

tm6 proceeding to vic of sp401 to get more info

TM1: 3/13/02 4:59 PM  
rgr

TM6: 3/13/02 4:54 PM  
roger on our way home

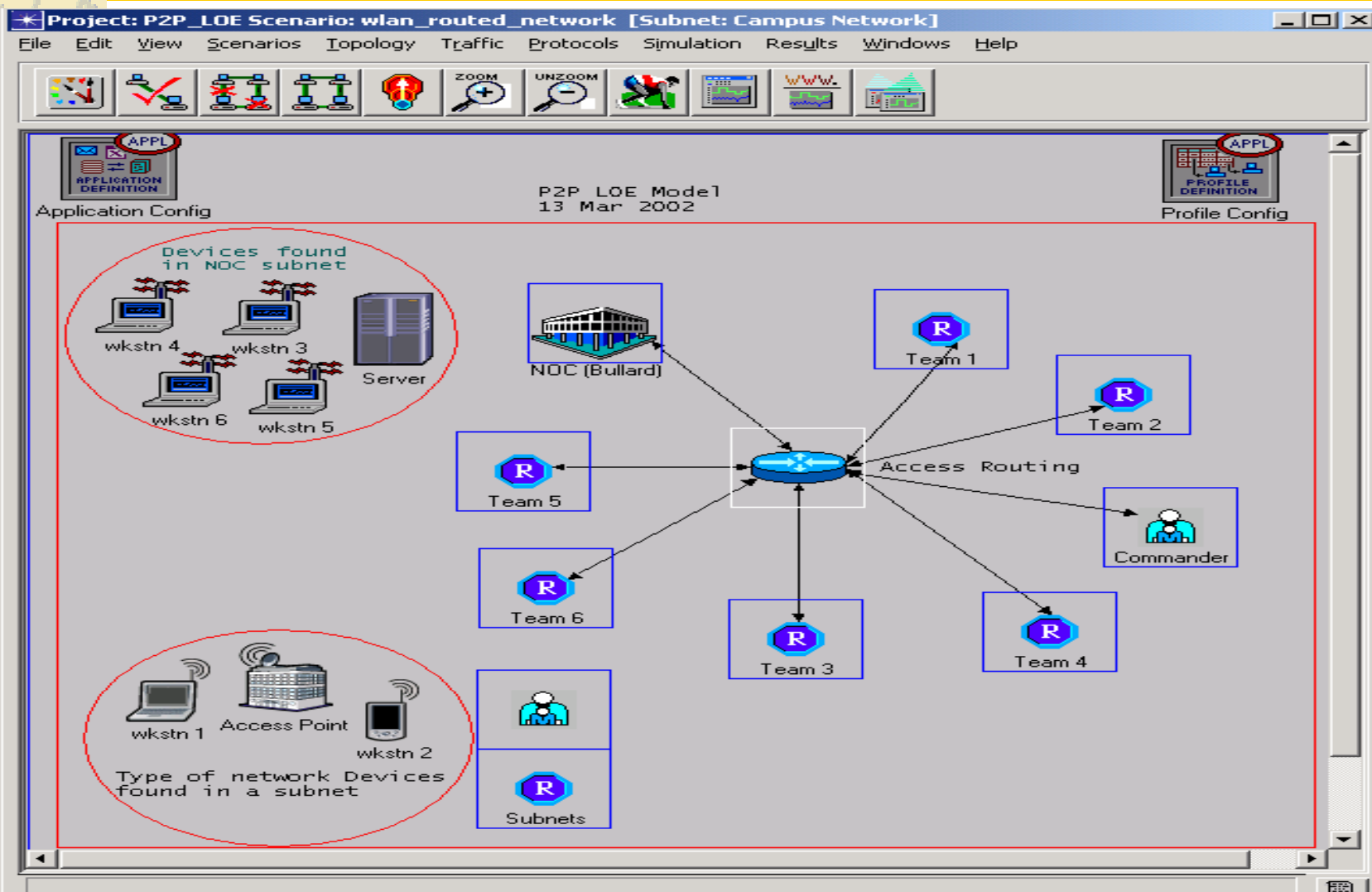
Uhlig, Bill: 3/13/02 4:59 PM  
RTB, fill out final SA Sheets

- Click here and type to chat with other members of the space -

Send Options



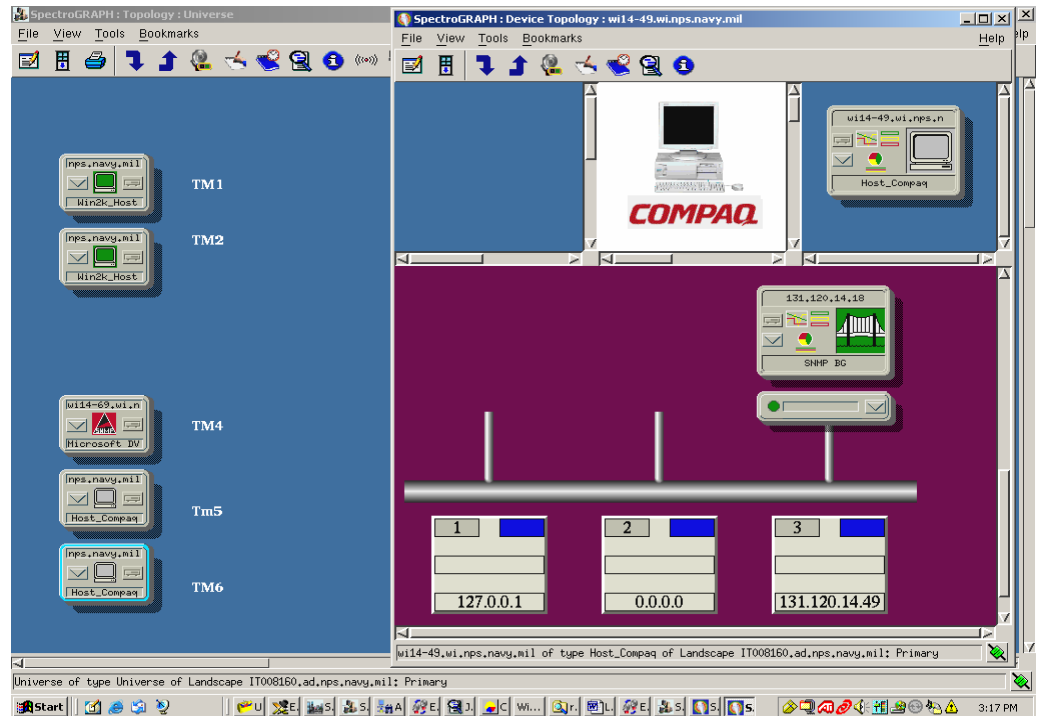
# P2P Tactical Collaborative Environment Topology





# Tactical Operations Center View of P2P Collaborative Network

- ✱ Network Management System Snapshot of P2P Topology during the experiment
- ✱ TM1-TM5 are S&R team members mobile units



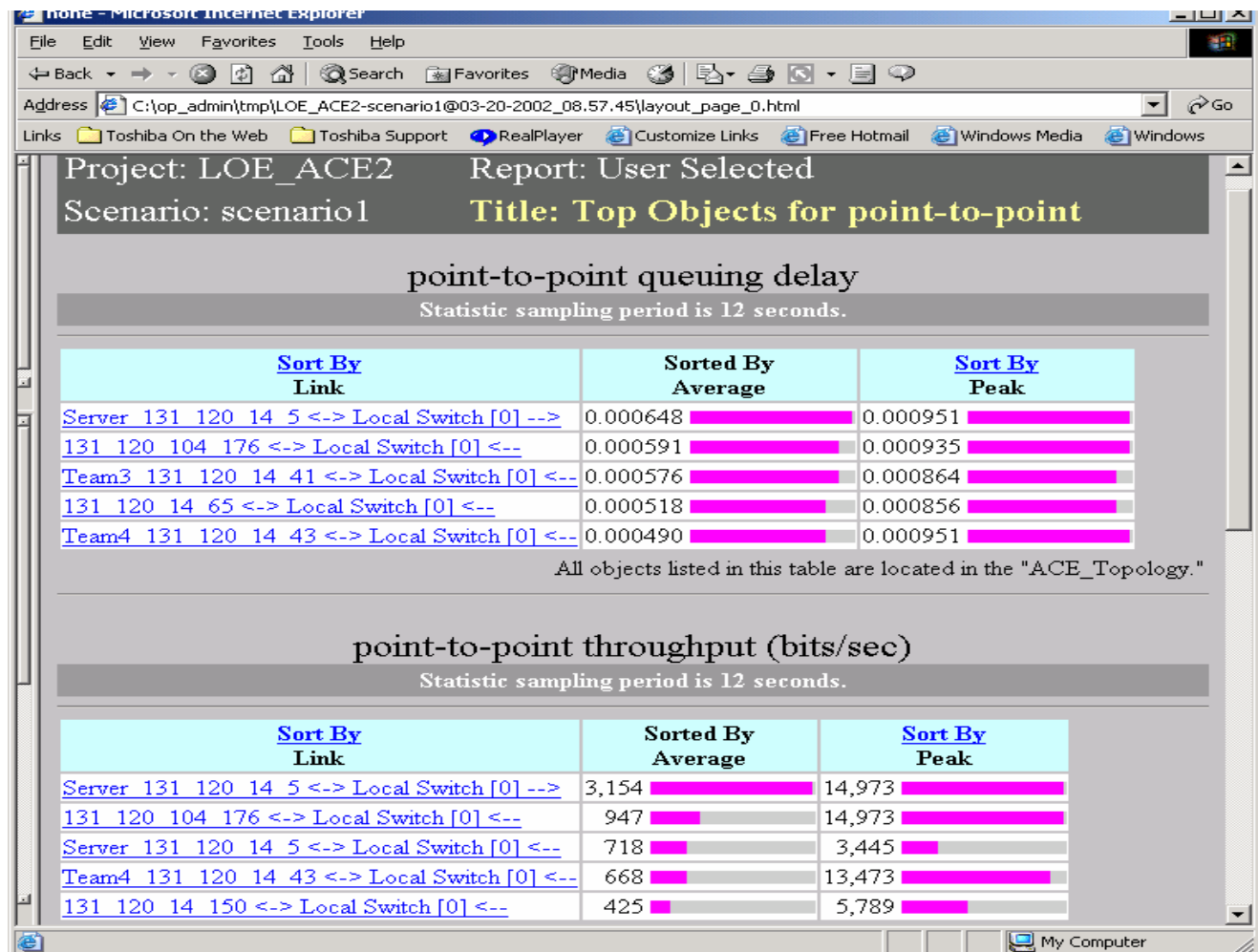




New level of feedback: network performance awareness

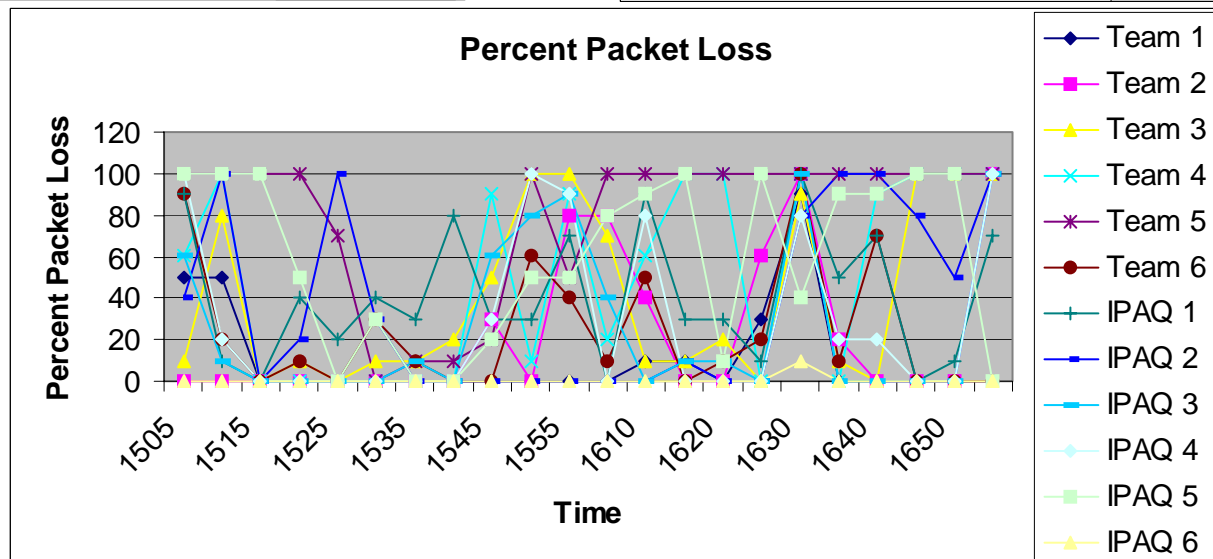
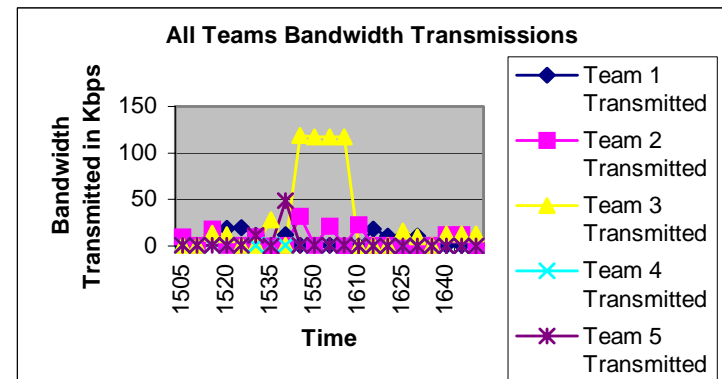
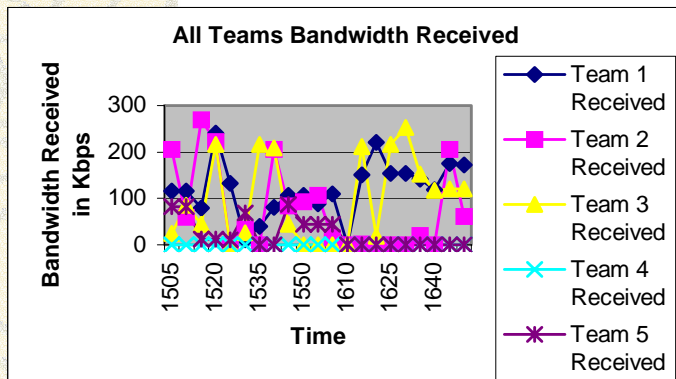


# P2P Throughput Analysis



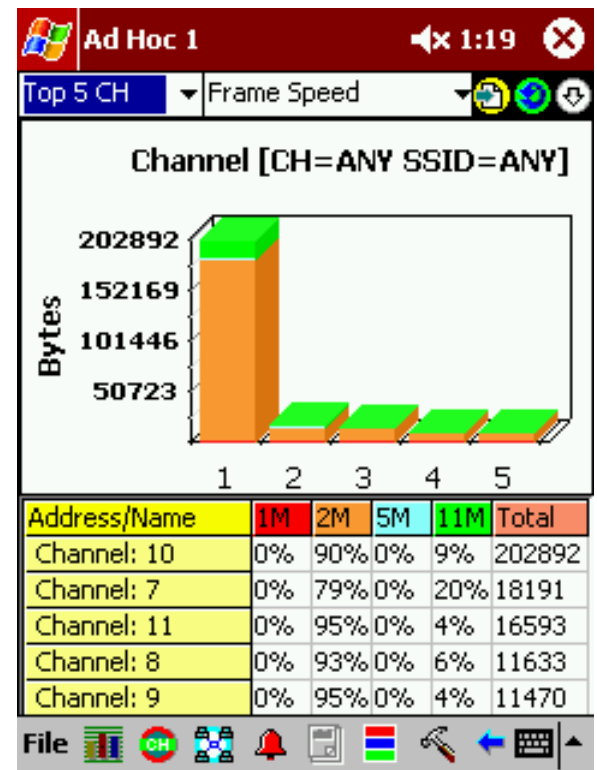
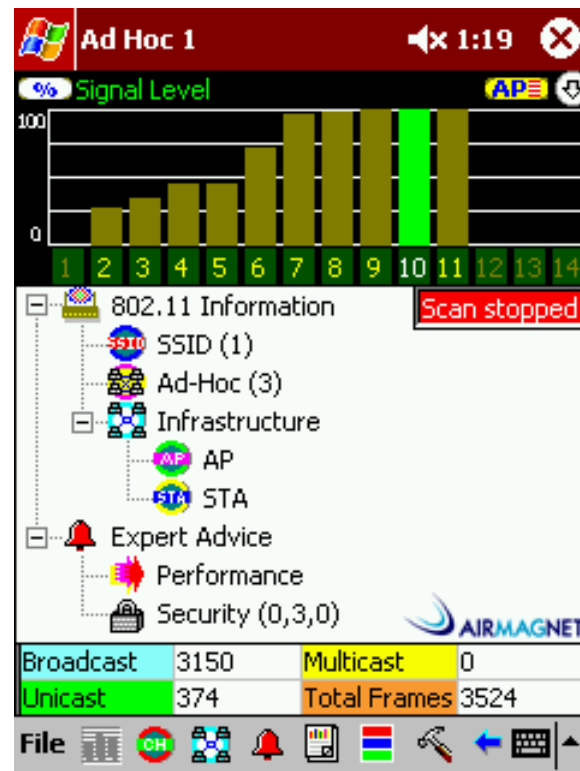


# Monitoring bandwidth and packet loss







# PDA View of Network Performance Feedback







# Self-Aware P2P Environment: Facilitator Model



# Establishing P2P Facilitator

- ✱ *We observed self-organizing behavior of R&S team members in switching the modes of communication*
- ✱ *The strongest and unexpected effect of self-organizing behavior emerged on the command center site: the P2P team created Facilitator*
- ✱ *Facilitator interpreted and shared in fly selected network performance data in order to synchronize the voice and data sharing calls between the team members*



# Additional Facilitator Functions

- ✦ Bandwidth management for P2P Groove clients

*This issue appeared to be critical form of operational feedback to the team members. They frequently used Orinoco client to identify the coverage and adjust their operations to the failing coverage. Groove client lacks such mechanism*

- ✦ Scalability and mobility

*The experiments proved scalability of wireless P2P collaborative networking. The main problems emerged in synchronizing voice communication that created a lot of interference. By some reason the members ignored using the voice messaging. Common opinion: wrong interface. The data sharing features scaled up easily.*



# Support for Access to C-S Sources

- ✦ Combining P2P with Client-Server communications

*Experiment proved P2P and C-S integration feasible, but sensitive to the roaming between the access points coverage areas. The P2P application sharing features yet underdeveloped in Groove appeared to be especially sensitive to roaming. They drop applications processing by crossing the boundaries with substantial packet loss. Restoration features are necessary*



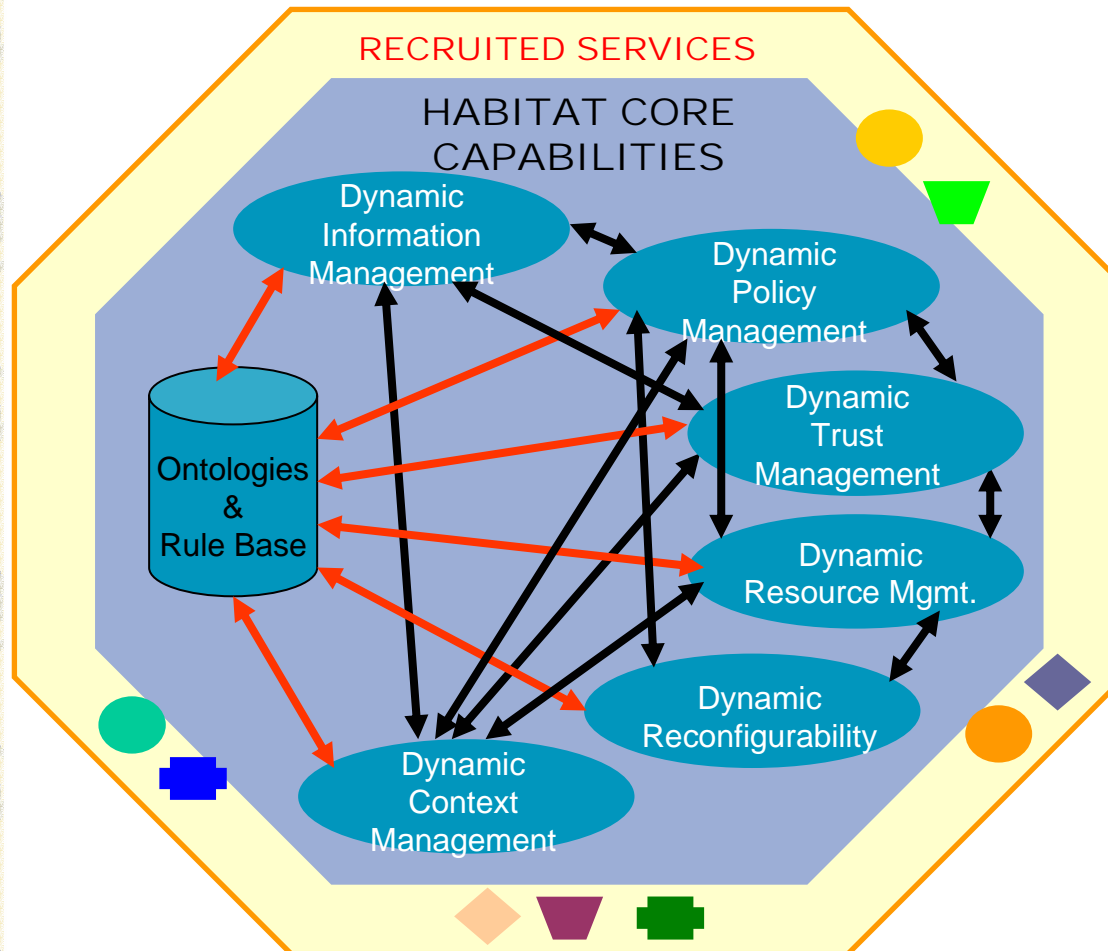


# Human Agent Habitats



# DARPA NICCI Habitat Approach

(NICCI stands for Network-Centric Infrastructure for Command, Control and Intelligence)







# Human-Agent Tactical Habitats

- ✱ Relief Operations Habitat
- ✱ Aircraft Carrier Deck Operation Habitat
- ✱ Network Operations Fusion Habitat
- ✱ Expeditionary Force UAV Networking Habitat
- ✱ SOF UAV Networking Habitat
- ✱ Ubiquitous Surveillance Habitat
- ✱ Search and Rescue Habitat
- ✱ SEALs Small Boats METOC Data Collection Network



# Humanitarian Operations Habitat

TECHNICAL EVALUATION WORKSPACE - Web Links - Groove

File Edit View Options Help

**TECHNICAL EVALUATION WORKSPACE**  
Web Links

NP56, NP56/Joint Experimentation J9 Ext...

Back Forward Stop Reload Add Favorite Up Browse Together

**Members** Invite

NP56, NP56/Joint Experi...

**Active**

- NP56, NP56/Joint ...

**Online**

- Bordetsky Alex(Jo...
- John Schwent
- Major Hezekiah B...
- Sam Chance

**Not Online**

**Suspended**

**Conversation**

Hold-to-Talk

Show Chat

Folder: Web Links (Root Fol...

Calendar Contacts Discussion Document Review Files Forms Meetings Notepad Pictures Sketchpad Web Links (1) Add Tool

http://131.120.179.99/loe/roccflash.asp

**ROCC Viewer**  
Ver 3.1  
15 NPS, 2003

Mark Davis  
Team ID: 2 (CoAES enabled)

Get GPS Stop GPS

Map: Oahu, HI

Message Box

**Info** **Alerts**

Lat.: 21°22.3038' N; 157°50.0996' W  
Long.: -157°50.0996' W; 21°22.3038' N

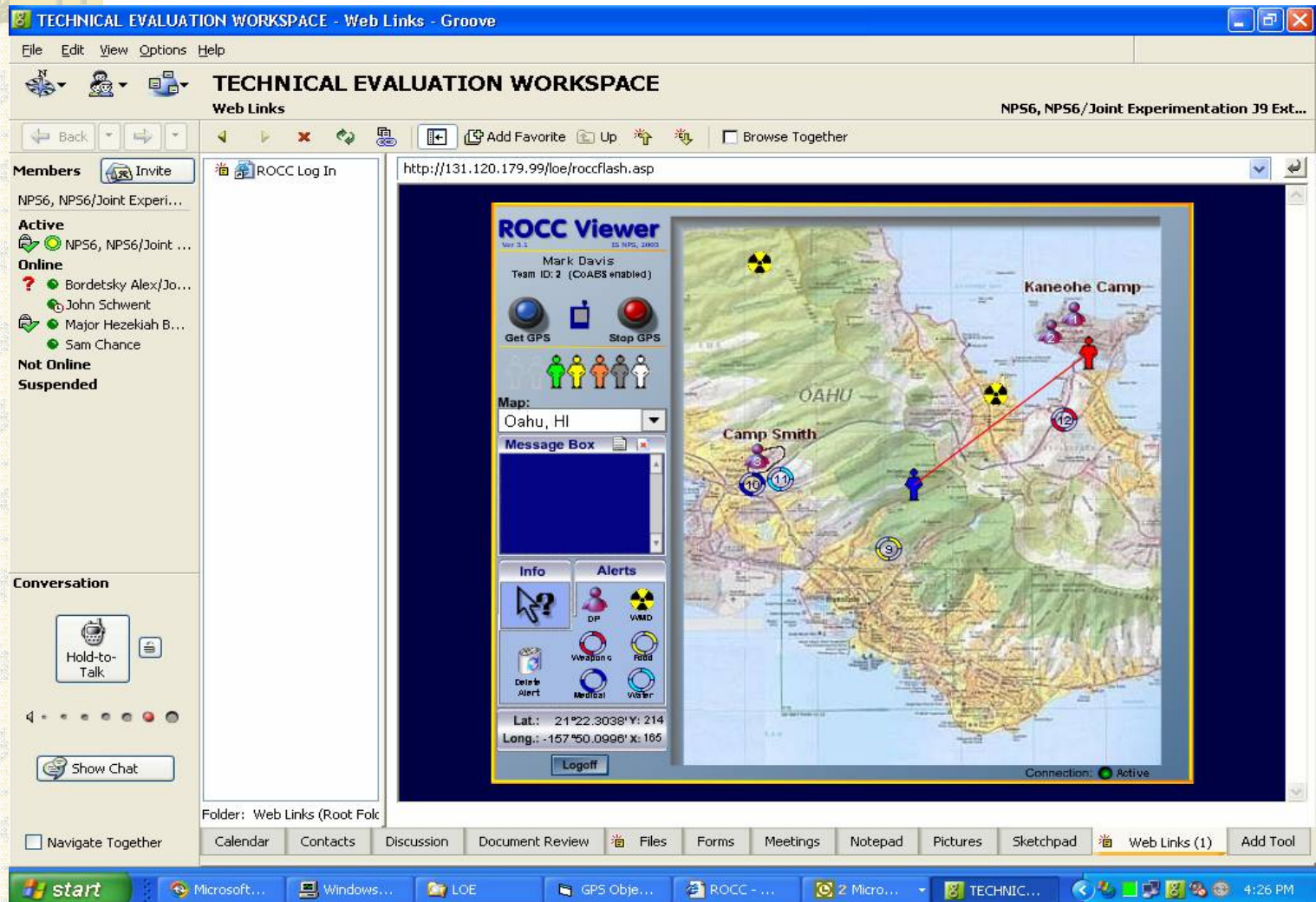
Logoff

Connection: Active

OAHU

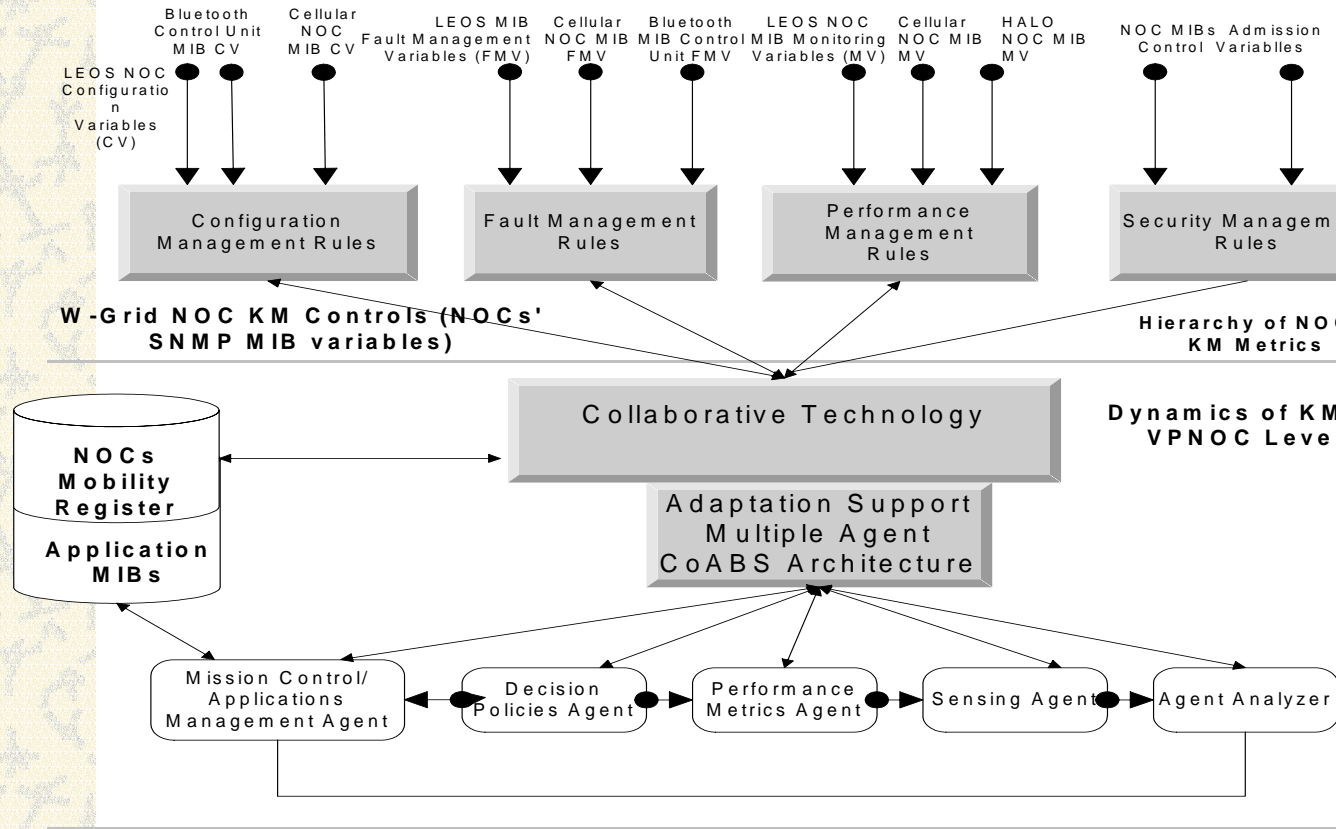
Kaneohe Camp

Camp Smith

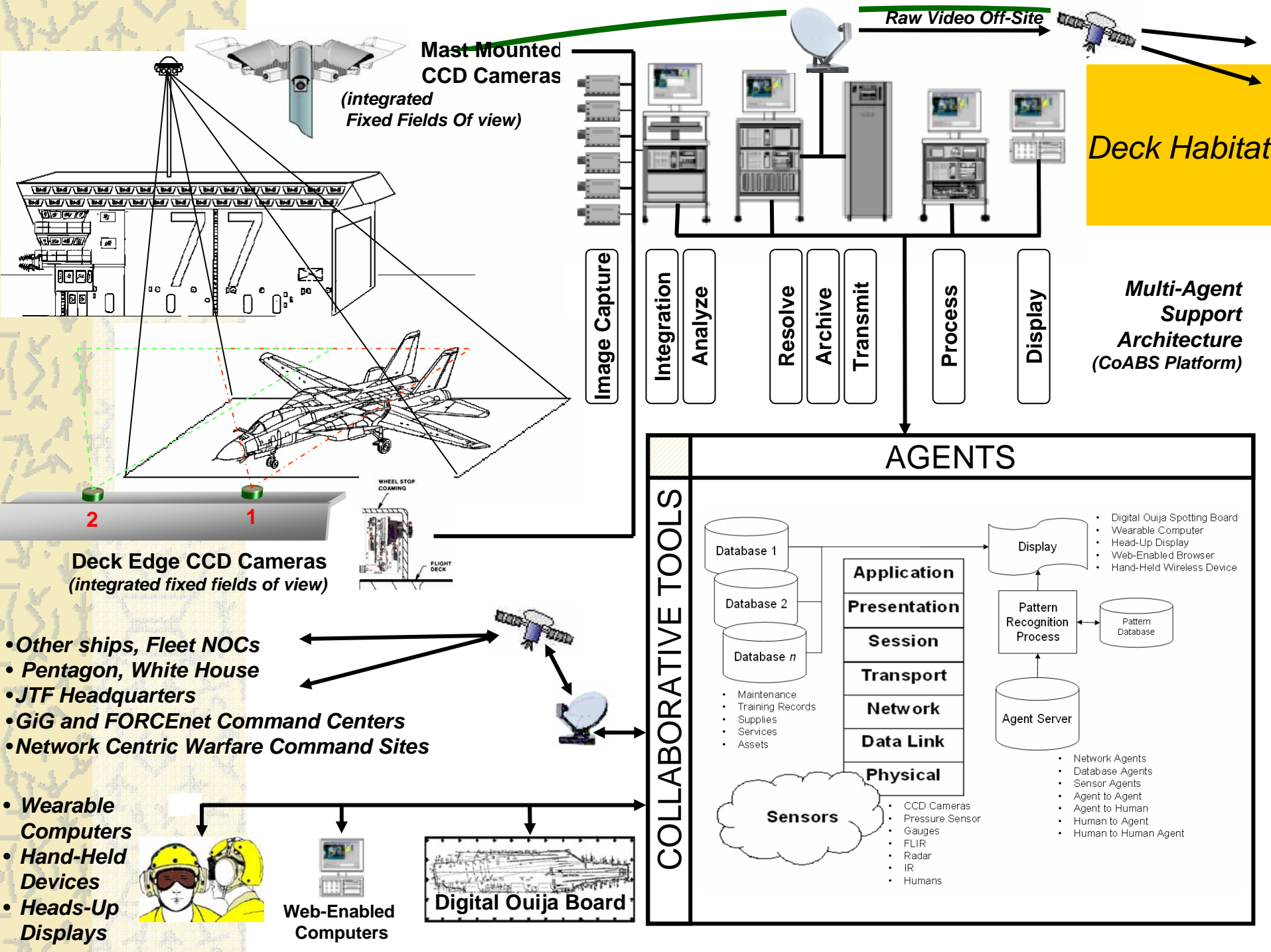




# Network Operations Habitat











# CKM Testbed: P2P Situational Awareness Integration with EWALL



# Objectives

- ✧ Providing testbed for exploring situational awareness, knowledge visualization, knowledge base construction, knowledge sharing, and consensus development aspects of applying collaborative technology to tactical level network-centric operations
- ✧ Providing set of proof-of-concept limited objective experiments addressing the challenges of tactical level team collaboration on planning and conducting the NEO missions.
- ✧ Providing flexible interface for plugging in the CKM collaboration products.
- ✧ Bringing location awareness to EWALL, advance EWALL philosophy in data relationship analysis via location based information
- ✧ Bringing EWALL data fusion and association mechanisms to tactical peer-to-peer collaborative environments



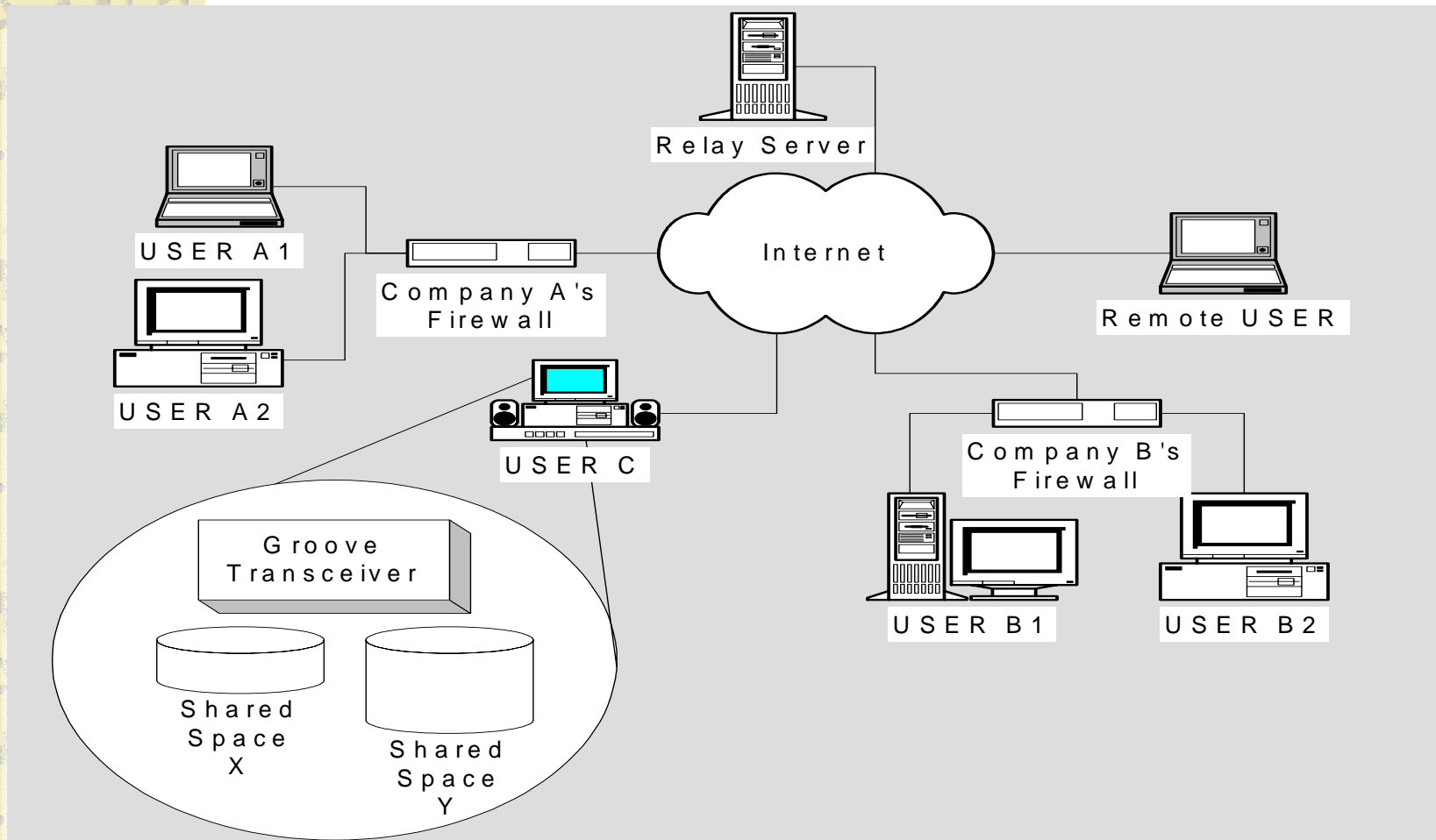


# Testbed Platforms

- ✱ MIT EWALL Client-Server Web-based Teamwork Environment
- ✱ Groove P2P Collaborative Shared Workspaces Network
- ✱ NAVAIR Groove-EWALL Modules
- ✱ NPS Self-Aware Human-Agent Habitat
- ✱ NPS Tactical Networks for NEO Experimentation



# Groove network peer-to-peer work space sharing architecture





# Groove Transceiver: Extended Presence Detection

The screenshot displays the 'NPS - Battle Rhythm Project - Document Review - Groove' application window. The interface is divided into several sections:

- Top Bar:** Includes a menu (File, Edit, View, Options, Help) and a status bar showing 'Revision 12' and 'Author: Eric Bach/Naval Postgraduate School'.
- Left Sidebar:**
  - Invite:** A button to invite users.
  - Active:** A list of active users including Cantemir and Charlie Ahcariu/N...
  - Online:** A list of online users including Axel, Bordetsky, Alex, borgqueen, Dennis Magsombol, Dieter Oros/Naval..., Eric Bach/Naval P..., Ron Montehermos..., Ryan Blazeovich/N..., and Todd Pugh/Naval ...
  - Suspended:** A section for suspended users.
  - Conversation:** A section for chat, including a 'Hold-to-Talk' button and a 'Hide Chat (2)' button.
  - Navigate Together:** A checkbox option.
- Main Content Area:**
  - Documents:** A list of documents including 'Eric Bach/Naval Postgraduate School' and 'BattleRhythm\_Project\_Main'.
  - Comments:** A table with columns 'Document', 'Comment', 'Author', and 'Created'. The table is currently empty, with a message 'Select a comment above to view detailed information.'
- Bottom Bar:** Includes buttons for 'Files', 'Discussion', 'Web Links', 'Lyborian Map', 'Outliner', 'Document Review (2)', and 'Add Tool'.



# Groove-based shared situational awareness: adding location and content awareness via agents

The screenshot displays the **TECHNICAL EVALUATION WORKSPACE** application running within a Groove environment. The interface is divided into several sections:

- Members:** Lists participants in the workspace, including "NP56, NP56/Joint Experi..." and "Active" members like "NP56, NP56/Joint ...". It also shows "Online" members such as "Bordetsky Alex(Jo..." and "John Schwent", and "Not Online" members like "Major Hezekiah B..." and "Sam Chance". A "Suspended" status is also indicated.
- Conversation:** Features a "Hold-to-Talk" button and a "Show Chat" button.
- Navigation:** Includes a "Back" button and a "Browse Together" checkbox.
- Map:** Displays a map of Oahu, HI, with various markers and labels. Key locations include "Camp Smith", "Kaneohe Camp", and "OAHU". A red line connects two points on the map. The map is titled "ROCC Viewer" and includes a "Map:" dropdown menu set to "Oahu, HI".
- Tools:** Includes a "Get GPS" button, a "Stop GPS" button, and a "Message Box" section.
- Info/Alerts:** Contains a "Info" section with a question mark icon and an "Alerts" section with icons for "DP", "VMD", "Weapon", "Road", "Medical", and "Vuln".
- Coordinates:** Displays "Lat.: 21°22.3038' N; 157°50.0996' W" and "Long.: -157°50.0996' W; 155".
- Logoff:** A button to log out of the application.
- Connection:** A status indicator showing "Connection: Active".

The application is running on a Windows XP desktop, with the taskbar showing the "start" button and several open applications: "Microsoft...", "Windows...", "LOE", "GPS Obj...", "ROCC - ...", "2 Micro...", and "TECHNIC...". The system clock shows "4:26 PM".





## EWALL Integration

- ✱ Major challenge for present tactical P2P collaborative environments: lack of fusion and shared reasoning features
- ✱ One good answer: integration with EWALL
- ✱ First step- C2 GUI interface level
- ✱ Next step-multiagent grid: EWALL modules as grid services

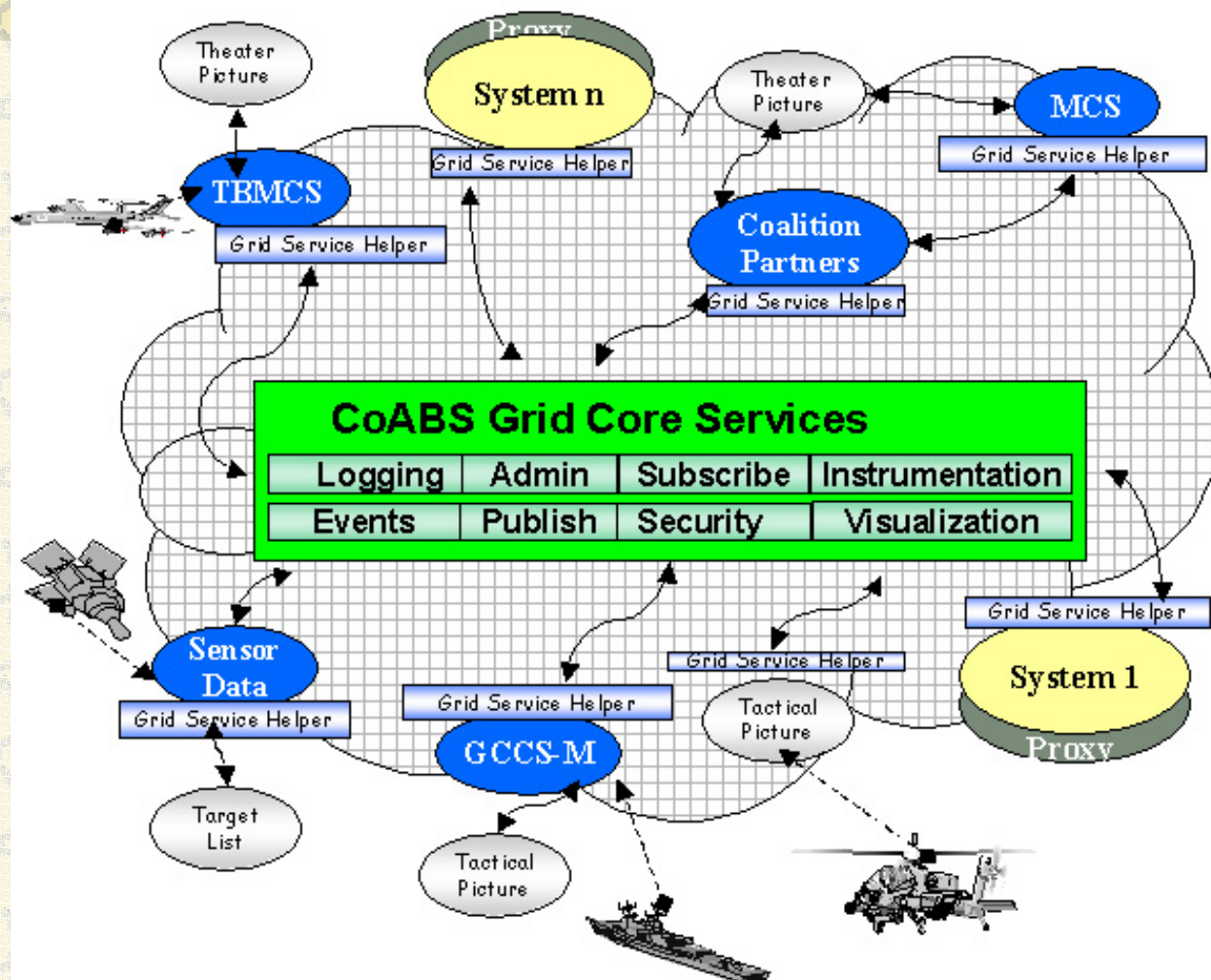


# ROCC Human-Agent Habitat

- ✦ ROCC: Relief Operations Coordination Center
- ✦ Using the principles revealed by the DARPA CoABS program, which deals with the techniques used to safely control, coordinate, and manage large systems of autonomous software agents, the NPS has developed an agent-based ROCC system for tactical level of Complex Humanitarian Emergency situational awareness. Its main mission is to give the users self-aware capability to maintain situational awareness on each other's location and have a common knowledge of events in their area of operations.
- ✦ The tool manages to integrate a series of in-house developed agents with the ROCC web-based application and with the Groove client. A short description of the functions covered by the two most important agents is:



# CoABS Grid: Multiagent Middleware





# ROCC Multiagent Architecture

- ✦ **The SA Management Agent** provides the visual interface display for all participants through their web browser and is intended to support the shared situational awareness for all the tool's users. It provides display capability for a great amount of information which allows a user to make informed decisions on how to assist in a particular event and also provides the necessary information to coordinate assistance.
- ✦ **The Tracking Agent** provides position-location information to the SA Management Agent for display in the browser. Data collected by the Tracking Agent comes from one of two input sources. One source uses manual inputs from the user who clicks and drags a user icon to a location on the display. The icon is then dynamically displayed to everyone accessing the ROCC. A second input source is from a GPS receiver. This is accomplished by enabling a software agent that takes the GPS receiver input and transmits it to the SA Management Agent in the ROCC, which subsequently moves the user icon to the correct location on the display. This method is much more accurate and requires no user input to adjust position information. This method of input is obviously hindered when a participant is obstructed from GPS detection (e.g. inside a building) or does not have a GPS receiver. In this situation, the user can easily switch to manual inputs by clicking the appropriate button on the ROCC display.
- ✦ Finally, the Complex Humanitarian Emergency Situational Awareness Tool may exist in two different spaces at the same time:
  - on the **web server** – that means it is accessible to all the users that can access the server where it resides;
  - on the **CoABS Grid** – which can be understood as the infrastructure layer that has all the of the agents and services running on it.



# ROCC Situational Awareness Multiagent Systems

## Agents

- Tracking Agent
  - GPS or Manual
- SA Management Agent
- CoABS Grid Agent
- Text Messaging Agent
- Database Agent





## ROCC Agent-Based Architecture for Situational Awareness Sharing

- ✱ Concept: 100% SA view sharing
- ✱ Client-Server Elements (C-S)
- ✱ Peer-to-Peer Elements (P2P)
- ✱ Flash based integration of C-S and P2P components
- ✱ Bandwidth Friendly
- ✱ CoABS integrated: immediate access to expert sources via the CoABS Grid





# Using ROCC Agents in CKM NEO Scenario





# TECHNICAL EVALUATION WORKSPACE

Web Links

NPS6, NPS6/Joint Experimentation J9 Ext...

Back Forward Stop Reload

Navigation icons: back, forward, home, search, etc.

Members Invite

ROCC Log In

http://131.120.179.99/loe/roccflash.asp

NPS6, NPS6/Joint Experi...

Active

NPS6, NPS6/Joint ...

Online

Bordetsky Alex/Jo...

John Schwent

Major Hezekiah B...

Sam Chance

Not Online

Suspended

Conversation



Volume control icons

Show Chat

Folder: Web Links (Root Fol...

Navigate Together

Calendar Contacts Discussion Document Review Files Forms Meetings Notepad Pictures Sketchpad Web Links (1) Add Tool

## ROCC Viewer

Ver 3.1 15 NPS, 2003

Mark Davis  
Team ID: 2 (CoABS enabled)

Get GPS Stop GPS

Icons: Green, Yellow, Orange, Grey, White

Map: Oahu, HI

Message Box

Info Alerts

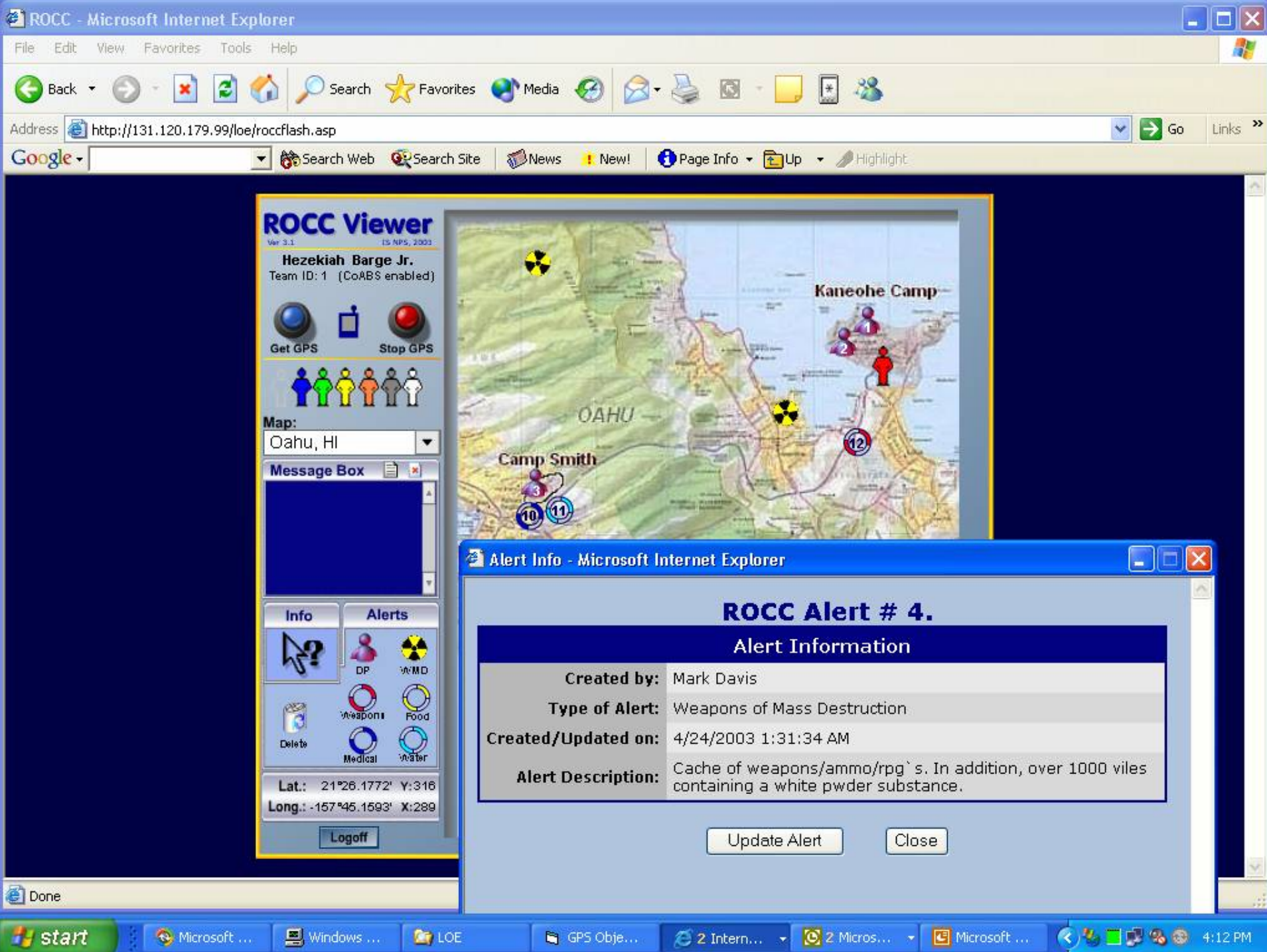
Icons: Mouse, DP, VMD, Weapon, Feds, Medical, Water, Delete Alert

Lat.: 21°22.3038' N; 214  
Long.: -157°50.0996' W; 165

Logoff

Connection: Active







**ROCC Team 1 Profile.****Team Information**

**Team Name:** Hezekiah Barge Jr.  
**Type of Contact:** Military  
**Rank or Position:** Major  
**Email address:**  
**Description:**  
**Color on the map:** Red

**Communication Options**

**Phone/Mobile # :**  
**Pager Number:**  
**GROOVE Agent:** Installed  
**Wireless networking:** Enabled  
**Video Camera:** Enabled  
**CoABS Agent:** Registered with Grid Manager to provide:

- Access to water supply DB

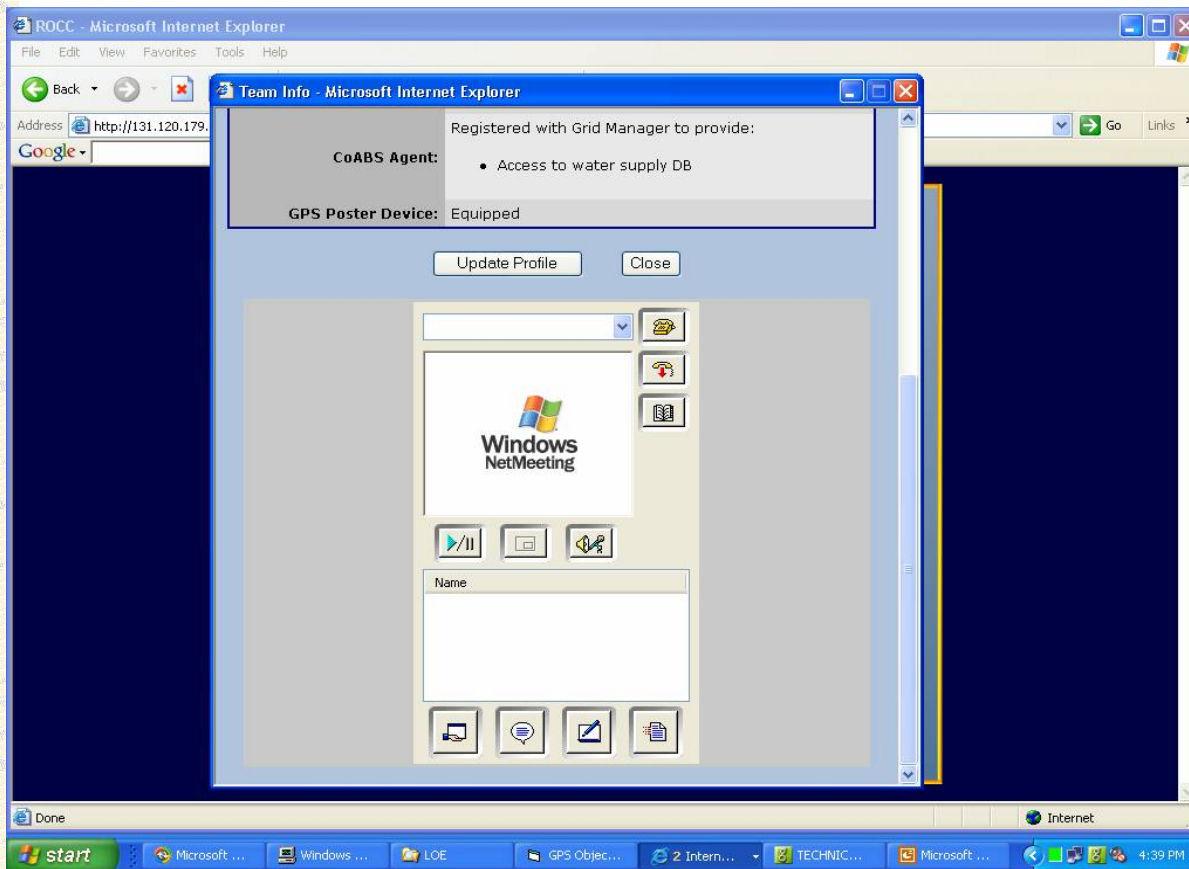
**GPS Poster Device:** Equipped

Update Profile

Close

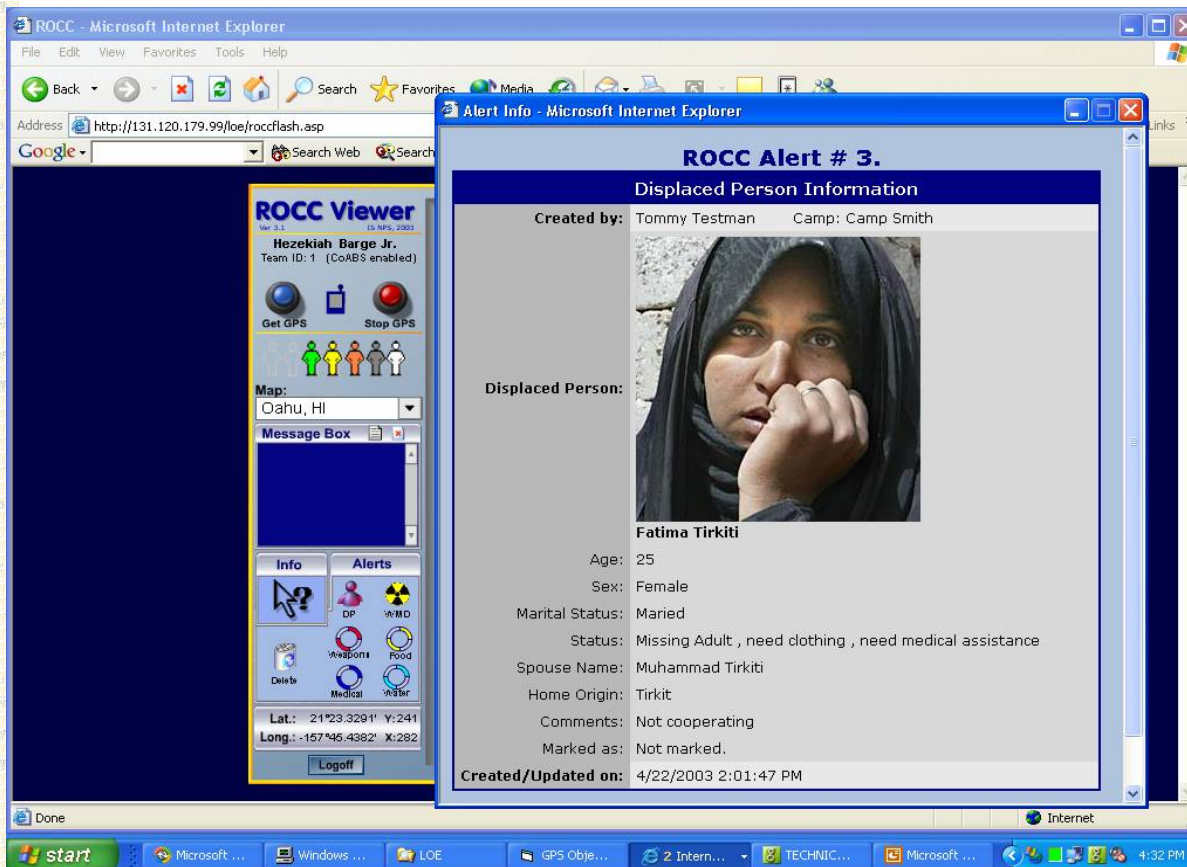


# Habitat member profile with embedded video access





# Displaced Person Alert





# Approach to EWALL Integration



Acrobat Document





Questions?